

What is claimed is:

1. A method for improvement of edge breakdown caused by edge electrical field at a tunnel oxide of a high-density flash memory by a shielded bird's beak, the method comprising
5 the steps of:

forming a plurality of trenches on a substrate, for
isolating a plurality of active regions;
forming a liner oxide on the plurality of trenches and
10 extending to respective edges of the plurality of
active regions;
depositing a first oxide filled in the plurality of
trenches for forming a plurality of shallow trench
isolations;
15 depositing a second oxide for covering the plurality of
shallow trench isolations and active regions;
etching the second oxide for forming a plurality of
bird's beak spacers at the respective edges of the
plurality of active regions; and
20 forming a tunnel oxide layer on the plurality of active
regions.

2. The method according to claim 1, wherein the
step of forming a plurality of trenches comprises the steps of:
25 forming a pad nitride on the substrate;

defining a pattern for the plurality of shallow trench
isolations on the pad nitride; and
etching the substrate with the pad nitride as a mask
for forming the plurality of trenches.

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3. The method according to claim 1, wherein the
step of forming a plurality of shallow trench isolations comprises
the steps of:

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depositing the first oxide by a high-density plasma
deposition; and
chemical-mechanical polishing the first oxide.

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4. The method according to claim 1, wherein the
step of forming a second oxide comprises a high-temperature
oxide deposition.

5. The method according to claim 1, further
comprising the steps of:

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forming a sacrificial oxide on the plurality of the active
regions after the formation of a plurality of bird's
beak spacers; and
removing the sacrificial oxide.

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6. The method according to claim 1, wherein the
liner oxide forms a plurality of initial bird's beaks at the

respective edges of the plurality of active regions.

5 7. The method according to claim 6, wherein the
bird's beak spacers are self-aligned to and shield the plurality of
initial bird's beaks.

10 8. A method for improvement of edge breakdown
caused by edge electrical field at a tunnel oxide, of a high-density
flash memory by a shielded bird's beak, the method comprising
the steps of:

 depositing a pad nitride on a substrate;
 defining a pattern for an active region and a shallow
 trench isolation on the pad nitride;
 etching the substrate with the pad nitride as a mask
15 for forming a trench;
 forming a liner oxide on the trench and extending to
 an edge of the active region for intruding under the
 pad nitride to form a bird's beak;
 depositing a first oxide filled in the trench and
20 covering on the pad nitride;
 polishing-back the first oxide;
 removing the pad nitride;
 depositing a second oxide for covering the first oxide
 and active region;
25 etching the second oxide for forming a bird's beak

spacer at an edge of the active region; and
forming a tunnel oxide layer on the active region.

5 9. The method according to claim 8, wherein the
step of forming a liner oxide comprises a high-temperature
oxidation at a temperature of about 1100-1200 °C.

10 10. The method according to claim 8, wherein the
step of depositing a first oxide comprises a high-density plasma
deposition at a temperature of about 400-550 °C.

15 11. The method according to claim 8, wherein the
step of polishing-back the first oxide comprises
chemical-mechanical polishing with the pad nitride as a
etch-stop layer.

20 12. The method according to claim 8, wherein the
step of depositing a second oxide comprises a high-temperature
oxide deposition at a temperature of about 800-900 °C.

13. The method according to claim 12, wherein the
first and second oxides are fused with each other.

25 14. The method according to claim 8, wherein the
step of etching the second oxide comprises an over-etching of a

thickness of the substrate at the active region.

15. The method according to claim 8, further comprising the steps of:

- 5 forming a sacrificial oxide on the active region after the
 formation of the bird's beak spacer; and
 removing the sacrificial oxide.